The Credibility of the Exchange Rate Regime: An Analysis trough "Derivatives" of the September 1992 Crisis

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Abstract:

This paper argues that, in the September 1992 European currency crisis, market trends in derivatives, in terms of price volatility and change in volumes traded, might have represented an early indicator, in reference to the spot market, of the lack of confidence in the ability of the Italian Lira and the Sterling Pound to maintain their parities within the ERM. The assessment is made by comparing the daily data on Italian/English interbank rates with the implicit yield on short-term interest rate futures and with a maximum compatible with the ERM band created by means of German interbank rates and changes in the exchange rates

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THE CREDIBILITY OF THE EXCHANGE RATE REGIME: AN ANALYSIS THROUGH "DERIVATIVES" OF THE SEPTEMBER 1992 CRISIS [*]

1. Premise and conclusions

This paper discusses the September 1992 currency crisis, which while it directly effected the Italian Lira and the Sterling Pound, involved the entire ERM system as well. This episode opens the way to an analysis of the rationale behind the behavior of operators in a specific, innovative and highly-specialized area of the financial markets, namely, derivatives, on the assumption that this market provided an early warning and, in some ways, a guide, compared to trading on the spot market.

In section 4, we shall see that the crisis was actually anticipated by the appearance of alterations in arbitrage relationships between the interbank, the short-term interest rate futures markets and a maximum interest rate compatible with the highest depreciation the currency was allowed within the fluctuation band under the terms of the ERM. These changes indicate the lack of faith in the Italian Lira to remain in the ERM band starting from the beginning of June, as well as for the Sterling signify a great deal of uncertainty in the period corresponding to the last few days of August.

As it is clear from sections 2 and 3, short-term expectations in the financial markets reflect the underlying dynamics of the fundamentals. From this point of view, we highlight the drawbacks of the *nominal anchor* theory as a means to acquire credibility by policy makers short on legitimacy, and we point to the discrepancies between nominal and real rates as signs for a future realignment, so as to characterize the September 1992 storm as an "announced crisis".

2. The European Monetary Union: theoretical justifications

From May 1987 (date of the French Franc's last realignment) to September 1992, the ERM proved to be an apparently credible system; it obtained significant results both by creating an area of relative monetary stability and effectively contributing to reduce

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Even though the paper resulted from a joint effort, sections 1, 2, 3 are to be attributed to G. Garofalo while F.Barbato is responsible for section 4.

inflation in Europe[1]. In 1986, with the signing of the *European Single Act*, the Community started removing controls on capital movements and the remaining non-tariff barriers to trade as well as creating an integrated market in banking and financial services.

However, these actions emphasized the growing incompatibility risks among the *a)* complete freedom of trade; *b)* total capital mobility; *c)* fixed exchange rates; *d)* little coordination of national monetary policies.

Considerations based on economic theory as well as empirical evidence show that the four elements of the "irreconcilable quartet" cannot coexist; thus, at least one must be abandoned[2]. Keeping the first three in place, it is possible to give up autonomy in national monetary policies and pursue the creation of a monetary union[3]. This is clearly the chosen path in the European Union Treaty (Maastricht).

This choice was supported by theoretical explanations that, on the basis of the rational expectations hypothesis, demonstrate how "by tying their hands" public authorities limit their discretionary actions and acquire credibility in their fight against inflation[4]. As is well known, the question is related to the *time inconsistency*[5] issue in the pursuit of optimal policies, which is the dynamic equivalent of Lucas's criticism.

Through the game theory, the time consistency solution can be defined as "Nash equilibrium" (or non-cooperative equilibrium point) in which no player can do better, given the strategy of the other. Time-inconsistent policies represent instead "Stackelberg equilibria", where authorities act as leaders thanks to information advantages and have an incentive to "cheat", thus to abandon the equilibrium point previously reached[6]. To achieve a better result of the Nash equilibrium in Pareto terms, the game should be made cooperative, though this is impossible due to the atomistic nature of the private sector. Given that the Stackelberg solution is unattainable in situations of perfect information, it is necessary that policy makers and operators enter

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[1] The average inflation rate in member countries decreased from 11% in 1980 to 2% in 1986. The difference between the highest and the lowest inflation rates diminished from 16 to 6 percentage points.

[2] Cfr. H.G.Wallich (1972) and T. Padoa Schioppa (1992).

[3] See the Delors Report published in 1990 entitled "One Market, One Money", *European Economy*, n.44.

[4] Cfr. F.Giavazzi and M.Pagano 1988; P. De Grauwe (1990 and 1992); T.Lane and L.Rojas-Suarez (1992).

[5] Cfr. F. Kydland and E.C.Prescott (1977).

[6] Cfr. J.W. Friedman (1986).

into an agreement that helps the system achieve its "natural" equilibrium by stabilizing expectations. The government effort can be confirmed by its reputation, besides laws or time-tested customs and conventions: in this case the incentive not to comply with the terms of the agreement must be more than compensated by the greater expected future costs generated by the loss of credibility[7].

It is not possible here to proceed with an accurate rebuttal of this approach. What must be pointed out, however, is that the concept of credibility must be set against a larger background that takes into account the benefits involved in the implementation of economic policies[8], as well as their costs[9]. Rational operators tend to anticipate the consequences of restrictive measures trying to subdue inflation by assessing their long-term sustainability. If they expect that future considerations related to the cost of unemployment[10] may lead to reconsider decisions made on economic policies, despite government assurance to the contrary, they will determine a differential in interest rates[11] as well as capital outflows, thus confirming expectations in advance.

In our country, for a number of reasons that cannot be investigated here (we will only point to the existence of "weak governments" with multi-party coalitions, unable to

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[7] S. Fischer (1990) emphasizes the existence, in a loss of authority function characterized by a stochastic disturbance unforeseen by operators, of a trade-off between the benefits deriving from dynamic consistency and the costs due to the absence of flexibility following the adoption of a strict monetary rule.

[8] Besides policy makers' greater dislike for unemployment than inflation, a government is interested in increasing the "inflation tax" in order to reduce the public debt. See A.L. Bovenberg, J.M. Kremers and P.R. Masson (1991) on this point.

[9] Cfr. P.R. Masson (1995).

[10] There is a "real unemployment cost" that cannot be defined in purely financial terms. Considering the loss of potential output and using a number of indicators to correct the measurement (average output of employed workforce; trend in the growth rate for a period - from the mid-60's to the early 70's - characterized by conditions of near full employment; implicit output-unemployment elasticity in Okun's law) we can conclude that for each percentage point in the rate of unemployment there is a 1 percent loss in GDP. An estimate of the real cost of unemployment in U.K and in the U.S.A is available in G.Dawson (1992).

[11] An indicator of credibility's structural deficit is provided by the persistence on a long-term basis (markets are said to be "short-sighted and long on memory") of a relatively constant difference between interest rate differentials and price differentials (a sort of "hard core" interest differential, after deducting the inflation rate). In the 1985-'95 decade, Italian securities carried a 3 percent "risk premium" over Germany's, compared to 1,5 - 2 percentage points between France and Germany. It must be noted that, before the currency crisis, in the 1990-'91 two-year period the gap between Italy and Germany, in a manner "inconsistent" with the trend, closed. Actually, there was even a small negative value, which was eventually corrected. Noteworthy is the result of the analysis of the same indicators in the comparison between the U.S.A and Germany. This highlights a clear reversal from marginally positive values to highly negative ones starting from the late 1980's-early 1990's with -5, -6 percentage point peaks right during the ERM storm (that was the start of a sharp depreciation of the dollar that would characterize the first half of the 1990's): such reversal is a clear sign of the redefinition of the relationship between the most powerful countries on both sides of the Atlantic, with the resulting turbulence as far as relations are concerned within the European area.

resist pressures from different social and interest groups and, thus, not in the position to keep the State's budget under control[12]), credibility has been sought by policy makers more through conventions or laws than custom. Reputation has then been pursued by public authorities more through self-imposed constraints than by their own conduct. It is in this framework that many Europe-oriented choices have been made in Italy; among these the idea to utilize the exchange rate as a nominal anchor, with the implication that the monetary policy should seek to attract a capital inflow consistent with the chosen parity.

Given the objective, subordinate role with respect to Germany, the type of monetary framework discussed above, valid for the majority of European countries, must defer to the monetarist policy of the country that is at the center of the system; this policy, since 1975, has been characterized by the setting of an "intermediate" objective in terms of quantity of money (growth of M3) and a "final" objective consisting in price stability[1314], to be achieved by making use of a wide range of instruments (repurchase agreements, currency swaps, below-market rate financing, marginal refinancing and mandatory reserves[15]).

3. An announced crisis

The euphoria of the moment led to an over-exaggeration, on one hand, of the stability of exchange rates as an external constraint to keep inflation in check and to reduce public debt, and, on the other, of the free circulation of capital as an opportunity to provide financing to national enterprises as well as a means to finance deficits in the balance of trade. Before 1992, however, the prevailing view made a minority out of those who

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[12] The benefits of exogenous institutional changes aimed at keeping public expenditures under the government's full control are outlined in P.R. Agènor and M.P. Taylor (1992).

[13] Although the monetary growth objective has been missed six times in the last twenty years, the Bundesbank's reputation was guaranteed by the stability achieved throughout the 1955-'94 forty-year period, with a 3.2% average annual increase in consumer prices, vis-à-vis 4.4% in the USA, 6.0% in France, 6.8% in the United Kingdom, 7.7% in Italy. It is this historical legacy, together with Germany's leadership within the ERM, that allowed the Bundesbank to save its own credibility in the period following Germany's unification, despite its temporary exceeding the limit of monetary growth.

[14] It can be useful to compare the Bundesbank's rule with that adopted in the U.S.A. where monetary authorities build up their credibility through custom and a consistent behavior over time. In the latter case there are many statistical indicators and the basic objective is to cope with inflation in the medium term.
It is appropriate to mention also inflation targeting since the United Kingdom, Sweden, Finland, and more recently Spain, resorted to it between the end of 1992 and the beginning of 1993, following the European currency crisis.

[15] See EMI, *Annual Report*, 1994.

raised the question of compatibility between national monetary policies and the underlying economic structure as well as other economic policies (budget policy, income policy, structural reforms) in the different countries. Only later was the awareness of the project's limits to gain wider currency [16] [17].

Noteworthy for the evaluation of the credibility of the economic policy regime implicit in the Maastricht's program, during the time-frame that is at the center of our attention, are the positions of those who saw the need for a "last realignment" for some countries before entering the EMU, in order to correct the real appreciation accumulated during the fixed parity period[18].

The summing-up throughout the years of inflation differentials, not corrected in a framework of nominal rates pegged to administrative parameters, produced an appreciation in the real exchange rate of the weak currencies (Sterling, Lira, Peseta, Drachma) with the ensuing loss in their exports' competitiveness[19]. In the second quarter of 1992, the real exchange rate for Italy, in comparison to other EEC countries, was 2.7%, 4.8% and 7.9% higher than the average 1987 value, depending on the indicator selected, based on producer prices, average export value per unit and labor cost per unit, respectively[20].

A confirmation of the discrepancy between nominal exchange rates and real exchange rates is given by the difference between the former and the Purchasing Power Parity (PPP); this represents the theoretical value of the exchange rate that allows to compensate for accumulated inflation differentials starting from a base period (January 1987 for the Lira; October 1989, the AEC membership date, for the Sterling)[21]. In June 1992, the PPP was close to 840 Lira per DM, if calculated on the basis of consumer prices, 776 Lira if in reference to producer prices, an overvaluation of 11 percent and 3

[16] Among the many interventions of the "revisionist" current the following can be mentioned: M.Pivetti (1992), H.Riese (1993), R. Azzolini and U. Marani (1993), A. Graziani (1994), M. De Cecco (1994), L. Bosco, R. Tamborini and F. Targetti (1994-1995).

[17] Noteworthy is the opinion in L.E.O.Svensson (1993, p. 20): "Fixed exchange rates now seem much less effective as means to price stability than many of us thought before. Therefore, monetary stability and credibility has to be built at home with other means...Fixed exchange rates may be a complement to monetary stability and credibility at home..., although they are not a substitute. They are simply neither necessary, nor sufficient for credible price stability".

[18] Cfr. K.A. Froot and K. Rogoff (1991); L. Spaventa (1992).

[19] The figure on page 30 in the 1993 *Report* of the Bank of Italy may be of some interest.

[20] The Bank of Italy's elaborations on OECD, IMF and Istat data are reported in the *Bollettino Economico* n. 19, 1992.

[21] Elaborations on the OECD data are in CER *Report* n. 4, 1992.

percent, respectively, compared to the exchange rate parity. Both PPP's were clearly out of the ERM fluctuation band.

The same thing can be said for the Sterling Pound; in this case both PPP's were slightly above 0.36 per DM at the date indicated, a 6.5% overvaluation with respect to the spot rate. Nor was the situation much different for Greece, Spain and Portugal, while Belgium, Luxembourg, the Netherlands, Denmark and, from the end of 1991, following the previous dramatic realignment, France showed a substantial stability in their own real exchange rates compared to the DM.

The behavior of the different players during the currency crisis deserves a careful reflection. The size of capital flows and the speed with which they move among the countries that participate to the European currency agreements cannot be understood unless there is some background information. Starting from 1987, financial operations among EEC residents, the cross-border investments, increased substantially. These transactions were part of an international diversification strategy of the investment portfolio that sought to profit from interest rate differentials among the different countries. In the countries whose economies and currencies were weaker[22], these investments were guaranteed by: a very low exchange rate risk, equal to the extent of fluctuations from parity; currency support measures by the EEC central banks also through interventions agreed upon within the European Monetary Cooperation Fund, the so-called very short-term financing facilities (VSTFF); the possibility to be protected from exchange rate risks by adopting cross-hedging strategies.

During July and August 1992[23], international and domestic private capital started abandoning the currency denomination that was considered weak and about to depreciate. Starting from the first days of September, the expected depreciation, caused by a general decrease in confidence in the ERM parity (we shall see that the bad news came from the Bath conference), turned into a devaluation forecast that paved the way for the speculative attack.

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[22] Think of the financial boom in Spain at the end of the 1980's.

[23] A factor often mentioned is the negative result of the Danish referendum held in June 1992 for the ratification of the Maastricht Treaty and the growing uncertainty on the result of the referendum set for September 20 in France.
As far as Italy is concerned, however, the preliminary phase of the crisis can be traced back to the month of June; the political and economic events that took place during that month are described in section 4.1.

The varying behavior of operators in the preliminary stage can be reconstructed with a certain degree of approximation. The hedge funds adopted two hedging strategies: on the one hand they sold in the forward market the weak currency in which the funds were denominated; and, on the other hand, they took a position in interest rate futures traded in London and Paris in order to hedge against the great volatility of interest rates typical of countries facing a devaluation risk. The majority of institutional investors, instead, continued buying securities denominated in the weak currency, hedging by taking an equivalent position in DM, so as to take advantage of interest rate differentials with a limited exchange rate risk. Besides a possible direct participation in speculative operations against their national currency, the banking system of the countries with a depreciating currency limited their activities to extending credit lines to those operators trying to liquidate long positions in the weak currency: such operations on the spot, swap and forward markets turned out to be extremely profitable both for the customer and the banking system.

Meanwhile the central banks of the countries facing difficulties intervened directly in the foreign exchange market to defend their own currency. They raised interest rates both to discourage the growing demand for credit and to make investments in national securities more profitable, thus encouraging the purchase of the currency in the spot market on the one hand and reducing the sale of securities in portfolio on the other[24].

The Bath conference, held on September 5 between Finance Ministers of EEC countries and central bank representatives, is the most likely turning point between the preliminary phase described above and the real crisis. In that occasion the *Bundesbank*'s governor, H. Schlesinger, refused once again to yield to the request of the other member countries who were urging Germany to reduce its interest rates. The renewed unwillingness to cut its interest rates made it plain that Germany intended to proceed toward a realignment of the parities within the ERM, thus abandoning a support policy for depreciating currencies carried out in the month of August. To international operators it was clear that the common policies pursued by central banks in order to defend the exchange rate parity was faltering. The weak currencies, already substantially

[24] The conduct of the Bank of Italy is described in the previously mentioned *Bollettino Economico*, n. 19, 1992 and in the *Report* 1993.

depreciated, were potentially headed for devaluation without a German guarantee: the "unusual" movement of funds made it clear that a speculative attack was in the making.

The timing of the crisis was most telling. The first currency to face difficulties was the Finnish *markka*, which had unilaterally been pegged to the ECU: on September 8, announcing that it would float, depreciated by 15%. On September 13 the Italian Lira was devalued by 7% while the Spanish Peseta followed suit with a 5% devaluation on September 17. On September 17 the Italian Lira and the Sterling Pound abandoned the ERM[25]. The crisis spread out[26] to involve the French Franc, the Belgian Franc, the Danish Kroner, the Dutch Guilder, the Swedish Kroner[27], the Norwegian Kroner, the Irish Sterling, the Portuguese Escudo and again the Spanish Peseta and the Italian Lira, perhaps in view of a possible return to the ERM in a short period of time.

The events involving the French Franc are interesting as there was the formal survival of the exchange rate agreement at stake. After being forced to hover around the minimum fluctuation values between September 17 and September 23, the French currency edged up again thanks to the political agreement reached in Paris after a meeting between F. Mitterand and H. Kohl, and thanks also to the reserve hemorrhage by both the Bank of France and the *Bundesbank.*

The nature of the speculative movements must be accurately defined. In fact, it is not possible to talk simply of sudden changes in the expectations of a devaluation for a single currency because there is a strong incidence of systemic factors related to the credibility of the exchange rate regime, as well as the degree of coordination of national monetary policies that occurs during a crisis, the latter representing a factor for the stabilization of expectations[28].

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[25] After realizing that nothing could be done to prevent the Pound from decreasing even further, the British government, on the evening of 16 September, unilaterally decided to temporarily suspend the currency from the ERM. In the morning of the following day, in the wake of this decision, the Italian monetary authorities ordered the official foreign exchange market closed until September 22.

[26] Cfr. M.Goldstein, D. Folkerts-Landau, P. Garber, L. Rojas-Suarez, M. Spencer (1993).

[27] The depreciation of the SK, unilaterally pegged to the ECU, vis-à-vis the DM was limited to 3% thanks to the dramatic decision by the *Riksbank* (the leading interest rate was raised to 500% in mid-September, and was reduced to 15.5% in mid-October), given the possibilities made available by the low inflation rate and by the low public debt level.

[28] The framework for the analysis is given by the literature on currency crises. See on the one hand the positions of the school of thought that refers to Krugman (1979), stressing rational choices by speculators in the presence of limits on the availability of foreign exchange reserves, and on the other hand the positions taken in M. Obstfeld (1994), F. Ozkan and A. Sutherland (1994), W.H. Buiter, G. Corsetti and P. Pesenti (1996) who refer to rational choices by policy makers, taking into account both

Within this context the "derivatives'" role is paramount. If in normal conditions they have a stabilizing influence on the underlying markets, allowing prices to adjust more rapidly to a change in factors that affect demand and supply, in times of tension they tend to increase the short-term volatility of prices. This reinforces the initial shock through feedback effects both on hedging positions, by setting in motion dynamic hedging techniques calling for purchases in spot markets where prices are rising and selling in those where prices are falling, and speculative positions by creating possible "speculative bubbles"[29]. The extreme sensitivity and the timeliness of the "derivatives" market's response to changes in expectations and/or in the economic variables must be attributed to the particular characteristics of these financial instruments. In fact, besides being actively traded and having a low transaction cost, a leverage and a particularly high risk/reward ratio, these instruments can be utilized either to hedge against an unfavorable change in price or for speculative purposes and short-term financial investments. The different objectives pursued by operators generate a highly composite demand for "derivatives" that, as it results from a variety of purposes, is always sensitive also to a peculiar external input.

Compared to the more complex, long-term credibility assessments, previously proposed, namely the general consistency of the exchange rate regime, the persistence in time of a difference between interest rate differential and price differential, the accumulation of discrepancies between nominal and real exchange rates, the prevailing tendency on the financial markets is to be guided by more direct parameters with a short-term horizon. It is on one of these that we intend to dwell in the next section.

4. The scope of the research and the arbitrage principles utilized to define the credibility analysis

In a study carried out in July 1994, J.M. Campa and P.H.K. Chang reviewed the degree of credibility of the fluctuation band of the Sterling Pound/Deutsche Mark exchange rate in operators' expectations between October 1990 and August 1992.

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costs and benefits associated to maintaining/abandoning parity, besides inflationary expectations by the private sector given a *reputational game* structure.

[29] Cfr. Bank for International Settlements, *Economic Bulletin*, n. 24, 1995.

In this period, which includes the 22-month stay of the Sterling in the fluctuation band set between a + 6.18% / - 5.82%[30] range from the declared ERM parity, the two authors analyzed the change in value of the option contract on the Sterling Pound /Deutsche Mark exchange rate.

The data reviewed - the daily average bid-ask prices of the option contract - were compared with a corresponding theoretical maximum daily value determined on the basis of the maximum depreciation compatible with the fluctuation band of the ERM parity for the Sterling Pound against the Deutsche Mark.

The value of the exchange rate call option at the closing T of the contract with a strike price equal to K is:

[1] $$Call_{t,T} = \text{Max} [0 , S_t]$$

where S_t is the value in Sterling Pounds of 1 DM at the time *t*.

With the participation of the Sterling Pound to the ERM, and with a fluctuation band deemed credible by operators, the maximum value the call option could reach at the maturity date T was (S°- K), where S° represented the limit of the maximum depreciation allowed for the Sterling Pound against the Deutsche Mark in the ERM.

Thus, given the credibility of the band, the value of the call option at the time *t* should have been lower than (S°- K) / (1 + $r_{t,T}$), namely the maximum value discounted for the time *t*.

Should the value of the call option (average bid-ask price) for a given period be higher than the maximum discounted value for the same period, it would indicate a condition of imperfect credibility for the parity fluctuation band, thus disrupting the arbitrage relationships at the basis of this test.

The option contracts for which a credibility analysis was performed were the 1-month call option, the 3-month call option and the 6-month call option. The first two contracts revealed only brief and occasional disruptions of the credibility condition, particularly in the period preceding the Sterling Pound's departure from the ERM (see figures 1 (a) and 1 (b)). The test run on the 6-month call option showed instead a clear lack of

[30] The participation of the Sterling Pound to the ERM, with a wider range around parity, was ratified on October 8, 1990.

confidence by operators in the ability of the Sterling Pound to remain in the fluctuation band (see fig. 1 (c)). The lack of credibility was very strong throughout 1992, with the only exception for the months of May and June.

By following the methodology adopted by Campa and Chang in their study, an attempt was made to derive an application of the analysis on short-term interest rate futures.

There are two reasons for choosing interest rate futures. On the one hand, as we set out to analyze the credibility of the Italian Lira within the ERM band, the only existing futures that could provide any information is the 3-month Eurolira traded on the LIFFE in London, due to the lack of exchange rate futures on the Lira. On the other hand, we intended to study arbitrage relationships, thus the correlation between the yields on Lira deposits both in the Euromarket and the Italian interbank market.

The analysis was then extended to the Short Sterling futures, the futures market for interbank deposits in Sterling Pounds, in order to evaluate its significance also with respect to the British currency. Thus, it was possible to compare the results with the outcome on the Eurolira futures, keeping in mind that the two currencies had different fluctuation ranges within the ERM band (+2.275% and -2.225% for the Italian Lira, +6.18% and -5.82% for the Sterling Pound), as well as more directly with the conclusions reached by Campa and Chang.

Fig. 1(a) - Credibility analysis on 1-Month Call Option

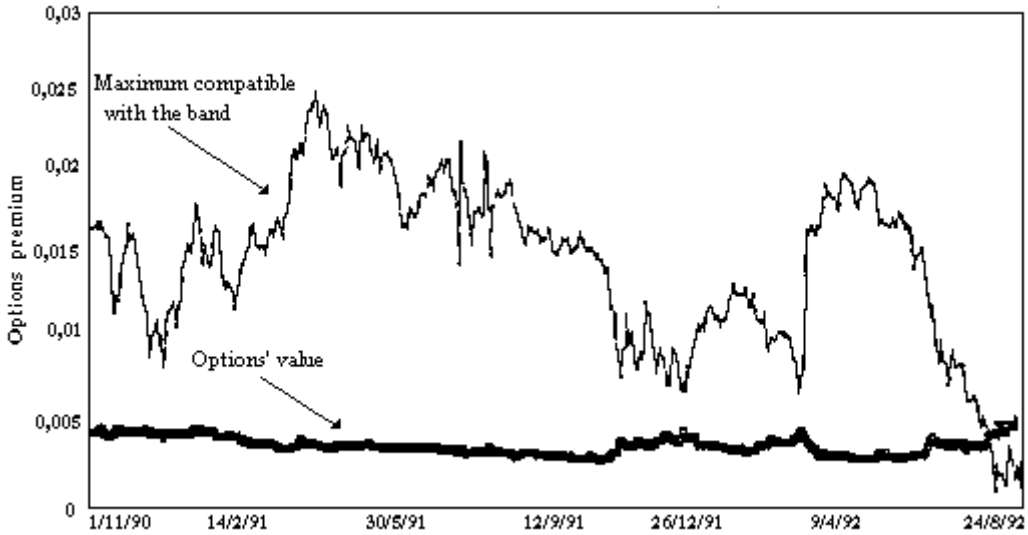


Fig. 1(b) - Credibility analysis on 3-Month Call Option

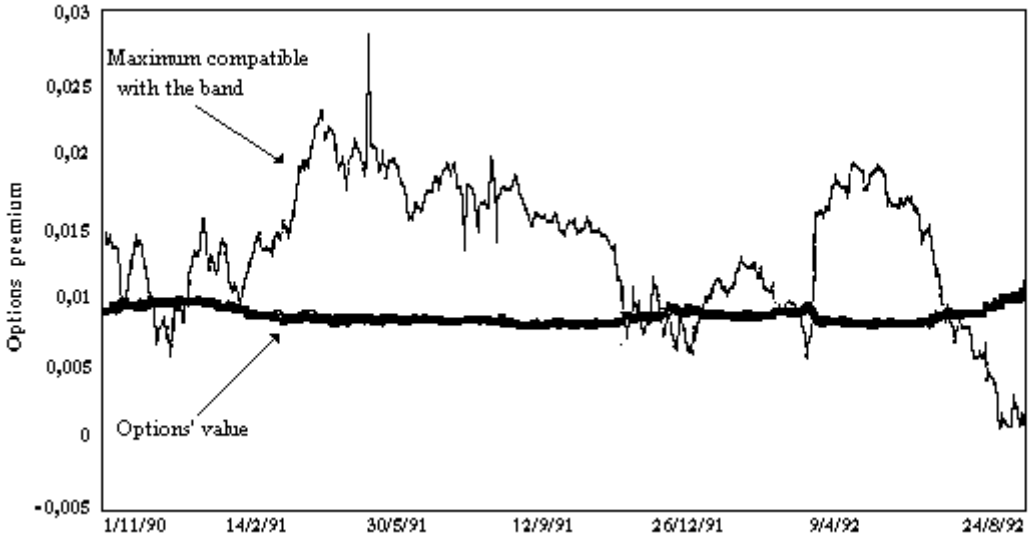
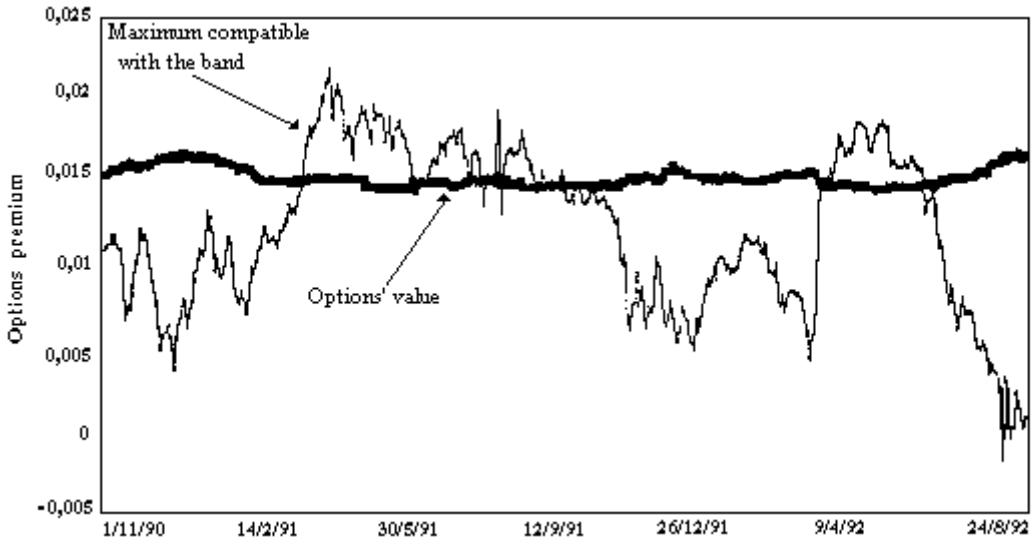


Fig. 1(c) - Credibility analysis on 6-Month Call Option



The two credibility analyses on the futures were carried out by taking into consideration the futures' daily closing prices in the months preceding the exit of the Italian Lira and the Sterling Pound from the ERM.

The price of a short-term interest rate futures contract in a given day is determined on the basis of the interest rate for the period considered. Thus, to calculate the theoretical equilibrium price of a 3-month futures, the three-month interest rate must be determined:

[2] $$y_{T1,T2} = \left\{ \left[\frac{1 + (i_{T,T2} \cdot (T2 - T) / 360)}{1 + (i_{T,T1} \cdot (T1 - T) / 360)} \right] - 1 \right\} \cdot \frac{36000}{T2 - T1}$$

where $i_{T,T1}$ and $i_{T,T2}$ are the interest rates at the time T with maturities at T_1 and T_2, respectively; T_1 is the last trading day of the chosen delivery period and T_2 - T_1 is equal to 3 months. Thus, if for example T_1-T is equal to 3 months, $y_{T1,T2}$ (implicit yield) represents a 3 month interest rate 3 months hence.

The futures price is then derived by subtracting $y_{T1,T2}$ from 100 :

[3] $f_t = 100 - y_{T1,T2}$

The test on the two currencies called for the daily analysis of the implicit yield (y_t)[31], which can be obtained through [3] from the daily closing of future prices.

The daily (closing) implicit yield for both the Eurolira and Short Sterling must be lower than or equal to the Italian interbank interest rate and the British interbank interest rate, respectively, so as to prevent arbitrage transactions between the two markets (interbank and futures) from occurring. In fact, if y_t is greater than the interbank interest rate (i_t) the arbitrageur might borrow in the interbank market and take a long position on the futures contract, thus making an arbitrage profit equal to $y_t - i_t$ when the implicit yield goes back in line with the interbank rate, owing to arbitrage pressures in the two markets.

In outlining arbitrage relationships, it was assumed that arbitrageurs would compare the two interest rates, expressed on an annual basis, keeping in mind the time interval between the trading day and the maturity date of the futures contract.

Thus, for instance, for a futures contract maturing on September 14, 1992, the implicit yield quoted on June 14, 1992 refers to a 3-month interest rate starting 3 months from now, or theoretically included between September 14, 1992 and December 14, 1992, that in terms of arbitrage, is compared to the interbank interest rate at 3 months, that is, the period valid from June 14, 1992 to 14 September,1992. This means that, in determining the profitability of their transactions, arbitrageurs look at the 3-month interbank interest rate three months before the maturity of the future; the one-month interbank interest rate one month before maturity; the 15-day interbank rate fifteen days before maturity, etc.

The construction of the curve i_t , therefore, took into account rates quoted on different dates and compatible with the expiration of future contracts.

The two curves i_t and y_t so determined, with $i_t \geq y_t$ for every t, were compared with a maximum interest rate compatible with the highest depreciation the currency was allowed within the fluctuation band under the terms of the ERM.

[31] In what follows the implicit yield is indicated by y_t , where *t* indicates the day of the quotation of the future.

The analytical expression of the maximum interest rate is:

[4] $$i_t^* = \bar{i}_t + \left(\frac{S^\circ - S_t}{S_t} * \frac{360}{g} \right)$$

where $\bar{i}_t$ is the German interbank interest rate expressed on an annual basis and with a maturity structure similar to i_t ; (S°-S_t)/S_t represents the change, in percentage terms, at the time *t*, of the currency from the maximum depreciation allowed with respect to the Deutsche Mark within the fluctuation band; *g* ,days that with time *t* indicate the expiration of the future contract.

Thus, [4] represents the maximum cost, in terms of currency depreciation, of an arbitrage transaction at the time *t* with financing obtained in the German interbank market, an investment in the national currency on the futures market for Italian and British interest rates and hedging the loan contracted in DM.

In arbitrage terms there can be two relationships between the interest rates under consideration:

1) $i_t^* > i_t \geq y_t$;

2) $i_t \geq y_t > i_t^*$;

The former indicates the condition of credibility for the ERM parity's fluctuation band. Confidence in the band is expressed by the negative value given by $y_t - i_t^*$ ed $i_t - i_t^*$, or by the existence of the arbitrage relationship between the German interbank market and the future and interbank markets of the currency being analyzed.

On the other hand, the latter shows a lack of credibility in the band. As $y_t - i_t^*$ ed $i_t - i_t^*$ are positive there is a clear disruption of the arbitrage relationships considered.

Contrary to the preceding, a third relationship in which $i_t > i_t^* \geq y_t$ might express an anomalous condition. In fact, in terms of credibility, the information reflected by the positive result of $i_t - i_t^*$ and by the negative result of $y_t - i_t^*$ is conflicting. In the analysis we have performed, this situation has been verified for brief periods during phases of high uncertainty.

4.1 The Italian currency crisis and the 3-Month Eurolira Futures. Credibility analysis on the Italian Lira/Deutsche Mark exchange rate in the months before the Italian currency's devaluation

Although the Bank of Italy's foreign exchange reserves had been steadily diminishing since January '92, due to the instability of exchange rates, the first signs of the currency crisis appeared in the month of June when Italian government securities sharply decreased first in the futures market and then in the spot market.

Investors' pessimism toward Lira-denominated securities originated in worries caused by some national political and economic events, such as: the lack of significant progress toward an improvement in public finance, the delay in the formation of a new government, the controversies on the new tax measures (especially concerning the "health tax"), the government announcement to proceed with the liquidation of EFIM without, however, repaying the latter's debts, Moody's downgrading (from AA1 to AA3) of Italy's creditworthiness in the ranks of industrialized countries.

The liquidation of Lira-denominated positions starting from the month of June, together with the speculative wave that developed in the following months, gave rise to such a strong pressure on the Italian currency that devaluation became unavoidable on September 13, 1992.

Table 1 lists the main events that characterized the Italian currency crisis, with a special emphasis on the Bank of Italy's interventions in the attempt to defend the Lira exchange-rate parity; in the last column, the Italian Lira/Deutsche Mark exchange rates outline the evolution of the Italian currency's depreciation.

The credibility analysis of the ERM fluctuation band for the Italian Lira/Deutsche Mark exchange rate is based on a comparison among the daily yields in the interbank market (i_t), the implicit yield (y_t) and the maximum compatible with the band (i_t^*), in the period between May 12, 1992 and September 14, 1992.

The futures contracts under review were the 3-Month Eurolira maturing September '92, and the 3-Month Eurolira maturing December '92.

The technical features of futures are described below:

Underlying	Exchange	Maturity	Index	Notional Value	Type of Delivery	Delivery Months	Delivery Day	Starting Date
Euromarket Italian Lira time deposit	LIFFE	3 months	LIBOR	1 Billion	Cash settlement	March, June, September, December.	First business day prior third Wednesday	May 1992

The results obtained by the analysis of credibility on contracts with a September and December, 1992 expiration date (see Figures 2 and 3) show the lack of faith in the Lira's ability to remain in the ERM band. For the two contracts, the period differs in which the positive values of $y_t - i_t^*$ and $i_t - i_t^*$ are obtained, obviously where there is an absence of credibility. This diversity conforms with that verified by the analysis of Champa and Chang for the English Sterling, where the absence of credibility is more explicit in contracts with long term options.

Furthermore, the analysis on the volumes of Eurolira contracts maturing December 92 traded in the month of September was particularly interesting. Data in Table 2 indicate the significant increment in volumes traded during the crucial four-day crisis, namely September 4, 9, 11 and 14.

Fig. 2 – LIFFE Eurolira maturing 09/92

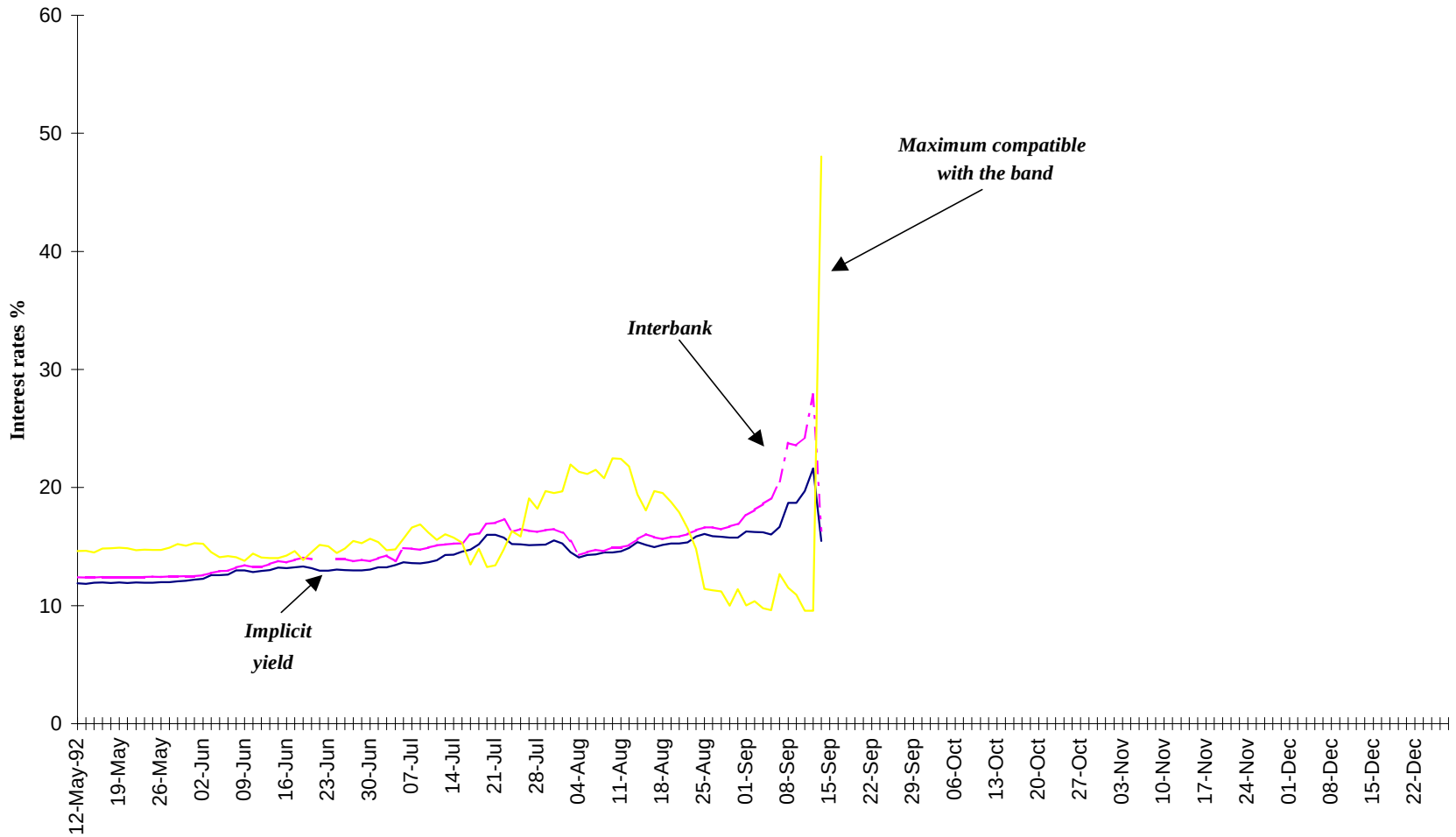


Fig. 3 – LIFFE Eurolira maturing 12/92

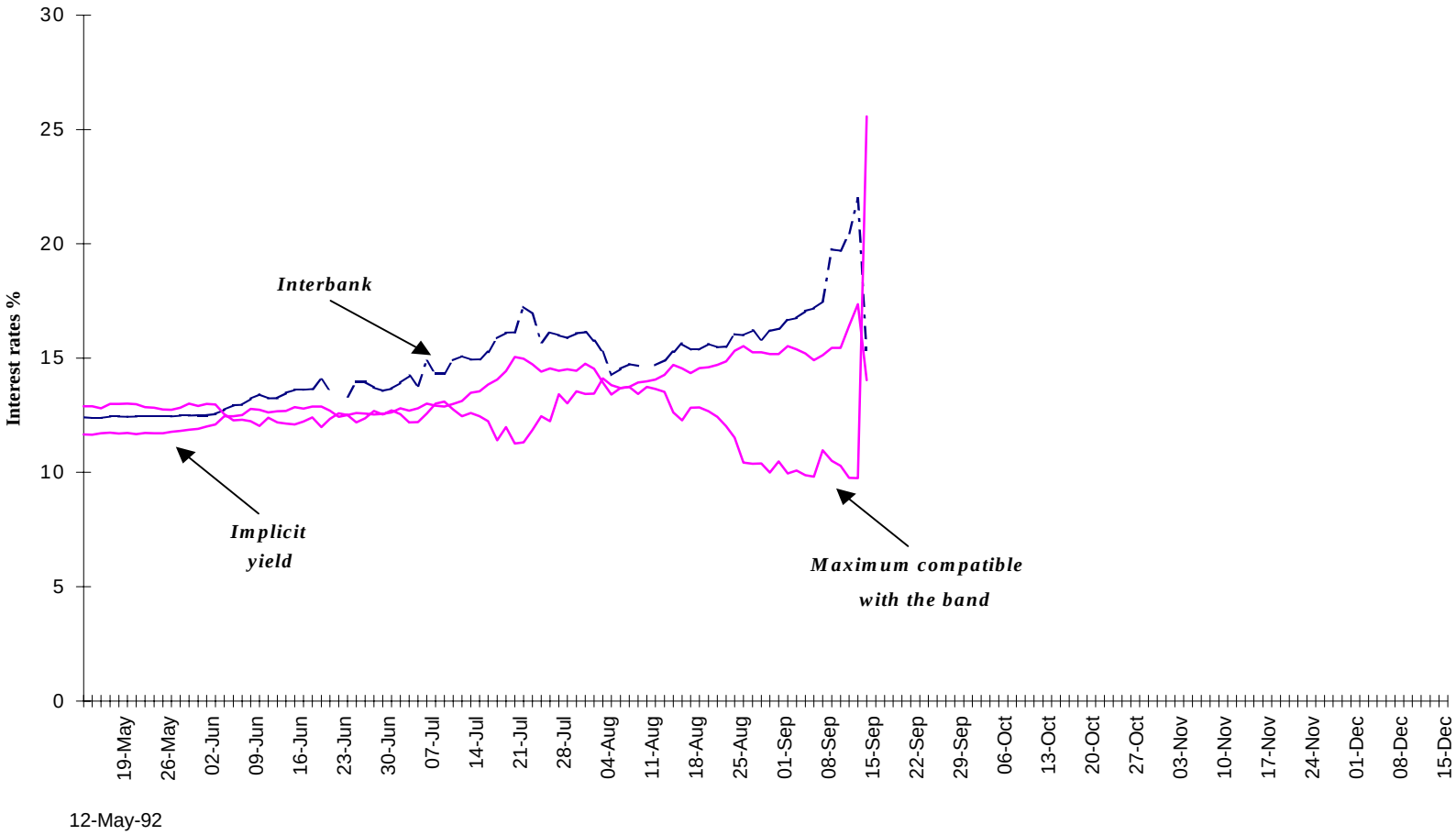


Table 1 - Events and Bank of Italy's policy during the crisis

DATE	EVENTS AND BANK OF ITALY'S POLICY	EXCHANGE RATE 1 DM=£
4/6/92	The Bank of Italy raises the fixed-term rate from 12.5% to 13%	756.03
5/7/92	The Bank of Italy raises the discount rate from 12% to 13% and the fixed-term rate to 14.5%	757.77
11/7/92	The Government announces urgent measures to reduce the public deficit	757.40
16/7/92	The Bank of Italy raises the discount rate to 13.75% and the fixed-term rate to 15.25%	760.75
31/7/92	Agreement among the social components and the Government on income policy, fight against inflation and cost of labor	756.33
4/8/92	The Bank of Italy lowers the discount rate to 13.25% and the fixed-term rate to 14.75%	755.83
4/9/92	The Bank of Italy raises the discount rate to 15% and the fixed-term rate to 16.5%; announces a VSTFF, raises banking reserves from 5% to 10% of deposits	765.40
9/9/92	Prime Minister Amato requests emergency powers	764.55
11/9/92	Last trading day for the Lira before the devaluation	765.40
13/9/92	The Lira is devalued by 7% against ERM parity	- - - -
14/9/92	First day of trading for Lira after devaluation	793.32
17/9/92	Lira abandons ERM	843.00
1/10/92	The Bank of Italy announces a medium-term loan obtained within the framework of the EEC's monetary cooperation agreement	879.00
6/10/92	Day of maximum depreciation for the Lira during the crisis	927.00
9/10/92	The Bank of Italy decreases the fixed-term rate to 16%	876.27
23/10/92	The Bank of Italy decreases the discount rate to 14% and the fixed-term rate to 15%. Reserve requirements on Lira denominated interbank deposits are repealed	876.31
26/10/92	The Bank of Italy issues for the first time a dollar denominated repurchase agreement	868.62
13/11/92	The Bank of Italy decreases the discount rate to 13% and the fixed-term rate to 14%	854.50
23/12/92	The Bank of Italy decreases the discount rate to 12% and the fixed-term rate to 13%	896.31

In particular, in the last trading day (September 11) before the devaluation, volumes increased by 67 percent compared to the previous day, thus determining a 17.35 percent implicit yield. The day following the devaluation the implicit yield fell by 3.32 percent to 14.03 percent.

The great volatility of the implicit yield was a recurring feature in the days between the devaluation of the Lira and its exit from the ERM. In fact, it was so remarkable that on

September 16 alone the futures yield varied by 4.2 percentage points, representing the difference between the highest and the lowest price.

Table 2 - September prices of Eurolira Futures maturing December '92

Date	Opening Price	Settlement Price	Highest Price	Lowest Price	Open interest	Volume Traded	Implicit yield
1/9/92	84,62	84,48	84,62	84,39	5983	1090	15,52
2/9/92	84,30	84,62	84,64	84,28	6096	861	15,38
3/9/92	84,55	84,80	84,83	84,50	6324	872	15,20
4/9/92	84,90	85,10	85,25	84,65	7238	3263	14,90
7/9/92	85,10	84,88	85,25	84,81	7275	894	15,12
8/9/92	84,45	84,55	84,66	84,35	7859	2346	15,45
9/9/92	84,00	84,55	84,75	83,50	8857	3342	15,45
10/9/92	84,40	83,60	84,40	83,60	9567	2310	16,40
11/9/92	83,65	82,65	83,65	82,08	9599	3859	17,35
14/9/92	85,25	85,97	87,40	85,40	9727	4600	14,03
15/9/92	85,90	83,95	85,90	83,25	10591	3978	16,05
16/9/92	83,40	86,10	86,10	81,90	10320	3473	13,90
17/9/92	85,60	86,78	87,10	84,45	9991	2210	13,22
18/9/92	87,10	86,90	87,10	86,40	9947	1778	13,10
21/9/92	86,70	86,28	86,70	85,78	9849	1604	13,72
22/9/92	86,23	86,73	86,60	86,00	9890	1693	13,27
23/9/92	86,75	86,58	87,15	86,45	9840	2069	13,42
24/9/92	86,58	85,65	86,58	85,30	9944	2309	14,35
25/9/92	85,45	85,84	85,90	85,05	9677	1538	14,16
28/9/92	85,70	85,59	85,80	85,40	9581	653	14,41
29/9/92	85,50	85,50	85,50	85,30	9601	828	14,50
30/9/92	85,20	85,34	85,49	84,50	9421	1843	14,66

The variability of the volumes traded, in the days preceding the devaluation, with respect to the implicit yields quoted raises some questions concerning the behavior of the operators who took a position in the futures contract.

The increment of volumes traded in the days preceding September 13 is directly attributable to the increase in speculative positions taken by operators. If on the one hand this explains the increment of the positions on the long side of the market, on the other the equivalent rise in short positions, necessary for market equilibrium purposes, is less clear. In fact, for instance, an operator who on September 11 had taken a short position by selling futures at 82.65, in case of a devaluation of the Lira, would have lost money by closing his position in any day following the devaluation.

With particular reference to the days between the Bath conference (September 5) and the devaluation of the Lira (September 13), the explanation in terms of "physiological" movements of the market is not convincing. It would mean, in fact, to state that the

speculative wave (long positions) originating in the weakness of the Lira was offset by an opposing speculative trend (short positions), that is by operators who, while betting on an increase in interest rates, continued to hold short positions also when it was time to close them.

A more convincing reason is given by the need to hedge some operators might have had in such a risky period in terms of profit and yield variability.

In an effort to protect themselves from the risks associated with a speculative exposure, investors with securities and cash balances denominated in a strong currency, to be converted at a later date, may have utilized the Eurolira futures market to secure a partial cover, thus implementing a mixed hedging and speculation strategy. By taking a short position, in fact, in case of a further increase in interest rates and a strengthening of the Lira, these investors would have made a profit on the futures and a loss on their balances; the opposite would have been true in case of a devaluation of the Italian currency.

An additional explanation that contributes to the shedding of some light on the increment of the short positions must be sought in the liquidity crisis that hit the Italian forward market in the days prior to the devaluation. As the possibility to operate on that market was precluded, there might have been a number of transactions that were carried out on the Eurolira futures instead, thus incrementing the number of positions on both sides of the market.

4.2 The British currency crisis and the Short Sterling Futures. Credibility analysis on Sterling Pound/Deutsche Mark exchange rate in the months preceding the exit of the British currency from the ERM

The speculative attack on the Sterling Pound took place in the days between the end of August and September 16.

Besides direct intervention in the foreign exchange market, the Bank of England's defense effort (see Table 3) called for the request of a VSTFF and the increase of the lending rate from 10 percent to 12 percent. The latter took place on September 16, together with the announcement of a further increase to 15% for the following day. This decision was not implemented as the British authorities decided to leave the ERM.

Table 3 - Events and Bank of England's policy during the crisis

DATE	EVENTS AND CENTRAL BANK'S POLICY	EXCHANGE RATE 1 DM=S.P.
3/9/92	The Bank of England announces a 5 billion ECU VSTFF	0.358517
15/9/92	Last trading day for Sterling Pound in the ERM	0.358677
16/9/92	The Bank of England raises the lending rate from 10% to 12% The Bank of England announces a further increase of the lending rate to 15% for September 17 The Pound Sterling leaves the ERM. The Bank of England cancels the lending rate increase expected for the following day	0.361731
17/9/92	First day the Pound Sterling was floated The Bank of England decreases the lending rate to 10%	0.378417
22/9/92	The Bank of England decreases the lending rate to 9%	0.395775
16/10/92	The Bank of England decreases the lending rate to 8%	0.411289

Throughout the attack on the Sterling Pound by the international speculation, the central bank's reserves went from $ 40.2 billion at the end of August to $ 31.7 billion at the end of September, $ 35.6 billion at the end of October and $ 35.9 billion at the end of November.

Compared to the policy adopted by the Bank of Italy, the Bank of England's defense intervention relied only marginally on changes of internal interest rates. In fact, interest rate increases represented the defense instrument of last resort for the British currency, utilized only a few hours before the Sterling Pound left the ERM.

The great caution shown by the Bank of England in changing interest rates are part of the Bank's time-honored tradition in the area of economic policy.

Customarily, in fact, the extreme sensitivity of the British financial market, one of the world's main financial centers in terms of volumes traded and internationally-oriented clientele, has always dictated a certain prudence to policy makers, and to the central bank in particular, concerning the choice of economic policies.

Fig. 4 – LIFFE Short Sterling maturing 12/92

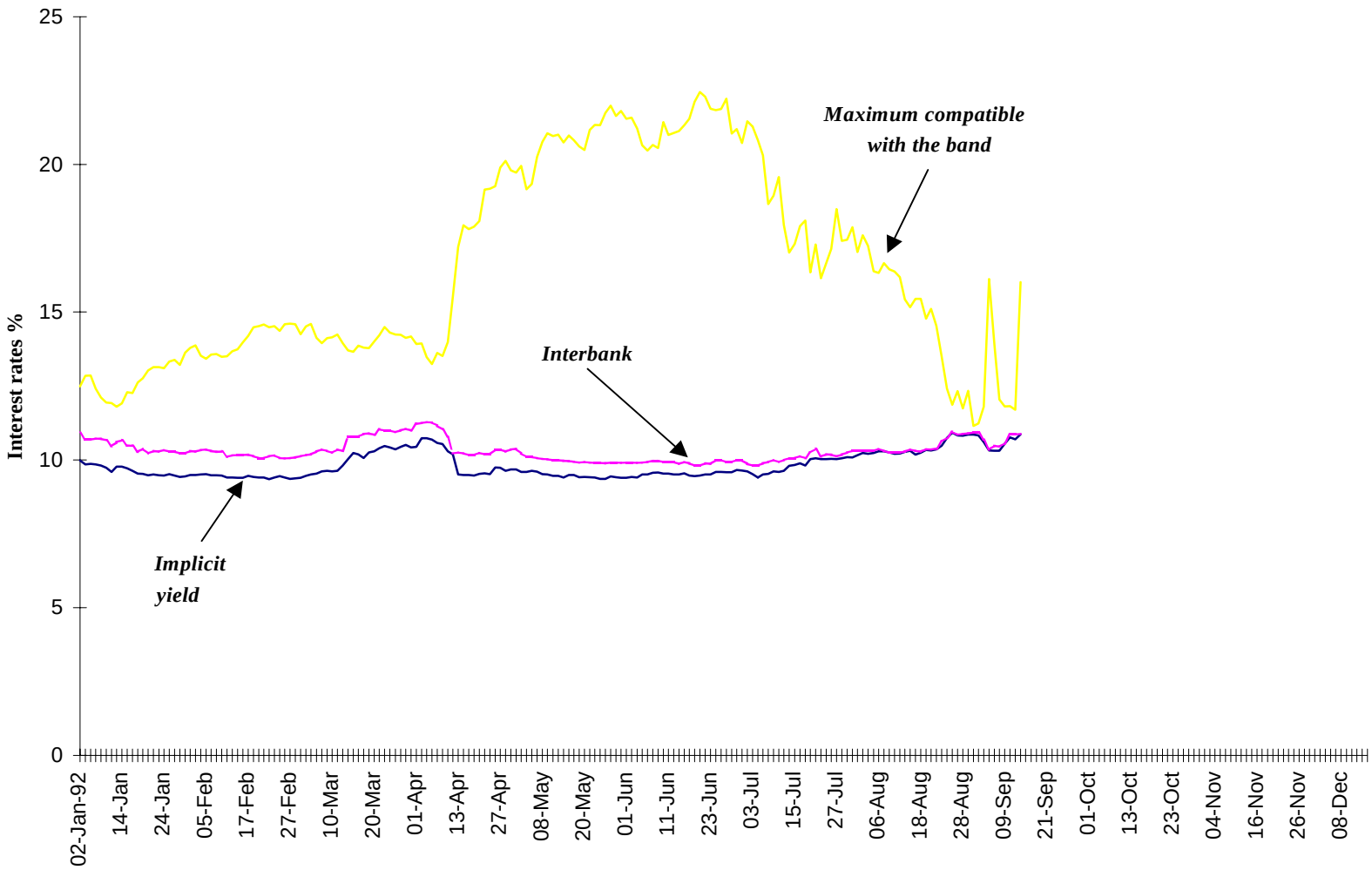
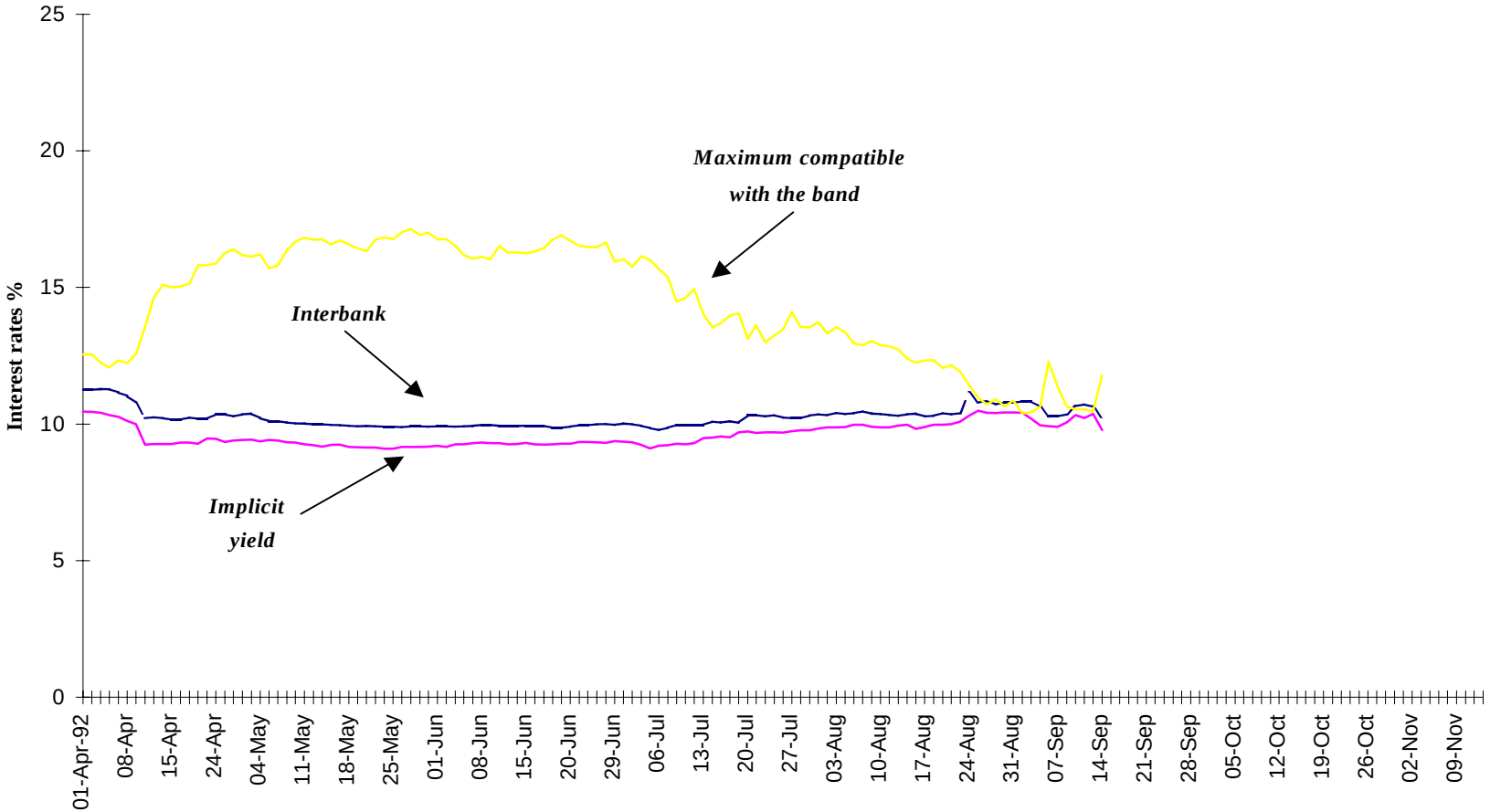


Fig. 5 – LIFFE Short Sterling maturing 03/93



The credibility analyses on the Sterling Pound-Deutsche Mark exchange rate within the ERM were founded on the review of the Short Sterling futures contracts maturing December '92 and March '93.

The technical features of futures are described below:

Underlying	Exchange	Maturity	Index	Notional Value	Type of Delivery	Delivery Months	Delivery Day	Starting Date
3-Month Sterling Pound Interbank Deposits	LIFFE	3 months	3-Month Interest Rate in Pounds	500.000	Cash settlement	March, June, September, December.	First business day prior third Wednesday	November 1982

The daily quotes for the interbank market (i_t), the implicit yield (y_t) and the maximum compatible with the band (i_t^*) have been analyzed in the period included between 2/1/92 and 14/9/92 for the contract with a December '92 expiration and in the period between 1/4/92 and14/9/92 for the contract with a March '93 expiration.

Fig. 4 shows the market's confidence in the ability of the Sterling Pound to remain in the ERM. This outcome is different from the conclusions in Campa's and Chang's study where there is a lack of credibility starting from October '91 to September '92, with the only exception of May and June. It must be pointed out, however, that the two tests are not consistent as the mentioned authors carried theirs on options, while we ran ours on futures.

The different maturity structure of the contracts on which the tests were performed explains the conflicting results. In fact, the lack of confidence between October '91 and September '92 was ascertained by Campa and Chang only for the 6-month call option contract, while for the 3-month call option contract there is a basic credibility condition for the period that preceded the crisis, in line with our results on the 3-month futures.

The test carried out on the contract maturing March '93 allowed, instead, to investigate the credibility condition in the days close to September 14.

The movement of y_t, i_t and i_t^* for the months of August and September is shown in Fig. 6 where the crisis period is analyzed in greater detail than in Fig. 5. This graph shows, starting from the 24 and 25 of August, positive values for $i_t - i_t^*$ and negative ones for $y_t - i_t^*$ giving, therefore, contrasting information on the credibility of Sterling in the ERM band in the days immediately preceding September 14. We see registered, moreover, between the 3 and 8 of September a sudden recovery of credibility due to the

announcement by the Bank of England on September 3 regarding a 5 billion ECU VSTFF.

Fig. 6 – LIFFE Short Sterling maturing 03/93. Detailed analysis of the crisis period

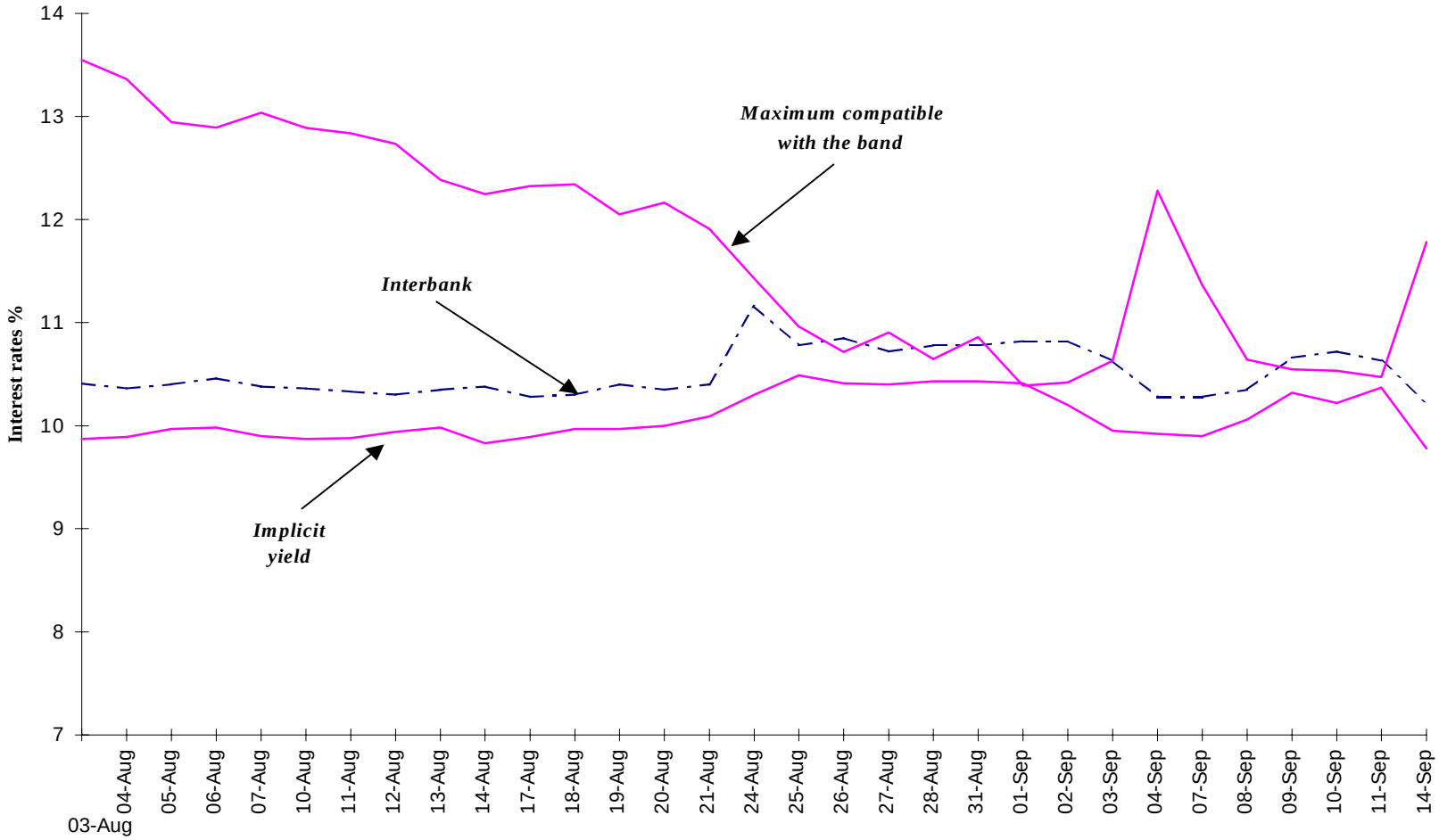


Table 4 - August and September prices for Short Sterling Future maturing December 1992

Date	Exchange rate	Opening Price	ettlement Price	Highest Price	Lowest Price	Open interest	Volume Traded	Implicit yield
3/8/92	0,35190	89,76	89,80	89,81	89,72	52245	6884	10,20
4/8/92	0,35233	89,81	89,76	89,83	89,74	53084	11201	10,24
5/8/92	0,35327	89,73	89,71	89,76	89,64	52994	13181	10,29
6/8/92	0,35339	89,68	89,71	89,75	89,67	52405	10026	10,29
7/8/92	0,35312	89,76	89,74	89,80	89,72	53505	9775	10,26
10/8/92	0,35351	89,73	89,80	89,81	89,73	54243	6880	10,20
11/8/92	0,35365	89,79	89,79	89,82	89,73	56351	10925	10,21
12/8/92	0,35389	89,78	89,73	89,81	89,71	56153	12241	10,27
13/8/92	0,35465	89,69	89,69	89,72	89,65	56203	10152	10,31
14/8/92	0,35496	89,66	89,82	89,83	89,62	57488	27622	10,18
17/8/92	0,35488	89,78	89,75	89,81	89,73	58524	10000	10,25
18/8/92	0,35497	89,73	89,67	89,74	89,65	60252	15494	10,33
19/8/92	0,35563	89,63	89,68	89,70	89,62	62191	21374	10,32
20/8/92	0,35539	89,68	89,64	89,74	89,62	64757	20051	10,36
21/8/92	0,35592	89,67	89,52	89,67	89,42	68246	29419	10,48
24/8/92	0,35692	89,35	89,26	89,39	89,21	72342	41215	10,74
25/8/92	0,35784	89,26	89,08	89,31	89,00	71960	52366	10,92
26/8/92	0,35831	89,14	89,17	89,22	89,00	74648	38585	10,83
27/8/92	0,35795	89,22	89,18	89,30	89,16	74985	29941	10,82
28/8/92	0,35845	89,21	89,14	89,22	89,11	75327	17084	10,86
31/8/92	0,35805	NA	89,14	NA	NA	75327	NA	10,86
1/9/92	0,35898	89,15	89,17	89,22	89,14	74421	15215	10,83
2/9/92	0,35893	89,17	89,40	89,46	89,16	73029	50442	10,60
3/9/92	0,35851	89,40	89,68	89,75	89,40	69704	48109	10,32
4/9/92	0,35538	89,78	89,69	89,89	89,54	71914	58496	10,31
7/9/92	0,35708	89,78	89,69	89,81	89,65	72527	16865	10,31
8/9/92	0,35840	89,69	89,46	89,75	89,42	75631	50457	10,54
9/9/92	0,35859	89,40	89,23	89,43	89,16	77135	63197	10,77
10/9/92	0,35860	89,17	89,30	89,35	89,14	77350	42697	10,70
11/9/92	0,35870	89,37	89,13	89,38	89,11	77311	50224	10,87
14/9/92	0,35581	89,89	89,74	89,95	89,62	75555	66186	10,26
15/9/92	0,35867	89,71	89,15	89,72	89,09	74736	93707	10,85
16/9/92	0,36173	88,65	88,65	89,2	87,45	82184	172140	11,35
17/9/92	0,37841	89,9	91,28	91,4	89,75	75496	119685	8,72

Comparing these results with those in the preceding section on Italian futures, it is evident the condition of distrust in the ERM parity is for the Italian Lira much more explicit and rooted in time. This result is not simply due to the greater fluctuation the Sterling Pound was allowed within the ERM, but it basically shows that the British currency was deemed more reliable than the Italian currency for most of the period of the monetary crisis.

The examination of the volumes of Short Sterling futures contracts with a December ‘92 maturity that changed hands (see Table 4) provides an additional analytical support of the test outlined in Fig. 6. In fact, in the first stage of the change of expectations between August 24 and 25, volumes traded show a marked increment compared to the previous trading day, thus revealing a large increase in speculative positions in the futures market.

As credibility was regained, from September 3 to September 8, volumes traded appear extremely volatile. In fact, those were days of great uncertainty for the foreign exchange market, both for the tensions arisen following the request for a VSTFF by the central bank, and for those originated by the outcome of the Bath conference on September 5.

Lastly, it is interesting to notice the growth in speculative positions between September 14 and September 16, a testimony to the perception of a possible departure of the Sterling from the ERM parity.

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